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8693
TEMPERATURE POTENTIOMETER

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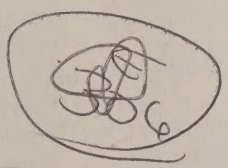

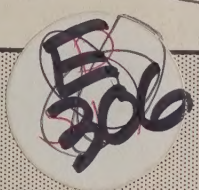

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8693

TEMPERATURE POTENTIOMETER

1. INTRODUCTION

The 8693 Temperature Potentiometer is a portable, battery-operated, double-range potentiometer designed for general plant and laboratory use. The instrument ranges are supplied according to the user's specifications, and include either two temperature ranges reading directly in degrees, one temperature and one mv range, or two mv ranges. Automatic reference-junction compensation is included with all temperature ranges. The instrument is designed for use with thermocouples or other emf sources. It can also serve as a source of calibrated voltage for checking other potentiometer-type instruments.

A general view of the potentiometer is shown in Fig. 1 and a detailed view of the control panel is shown in Fig. 2.

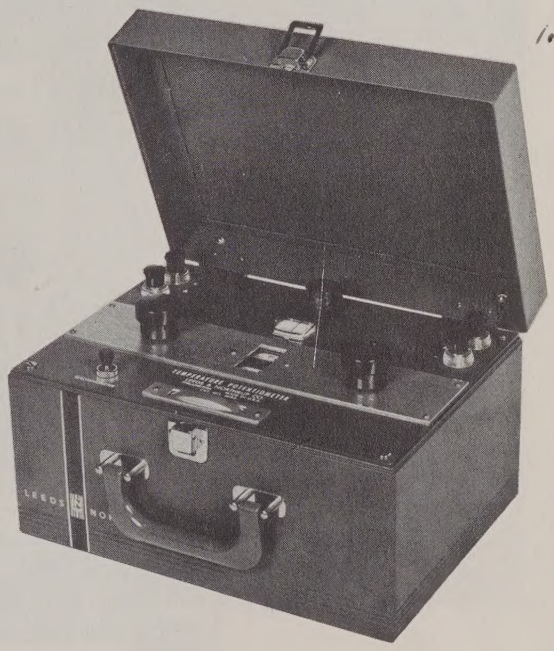

Fig. 1—8693 Portable Temperature Potentiometer.

2. SPECIFICATIONS

LIMIT OF ERROR: ±0.2% of range span for all standard ranges when external resistance does not exceed 50 ohms.

GALVANOMETER*:

Sensitivity: 1.0 microampere per scale division (equivalent to 45 microvolts per scale division for total circuit resistance of R_C + CDRX)

Galvanometer Resistance (R_C): 10 ohms

External Critical Damping Resistance (CDRX): 35 ohms

BATTERY: 1.5 volts

*Sensitivity at least as high as stated - other characteristics within ±20%.

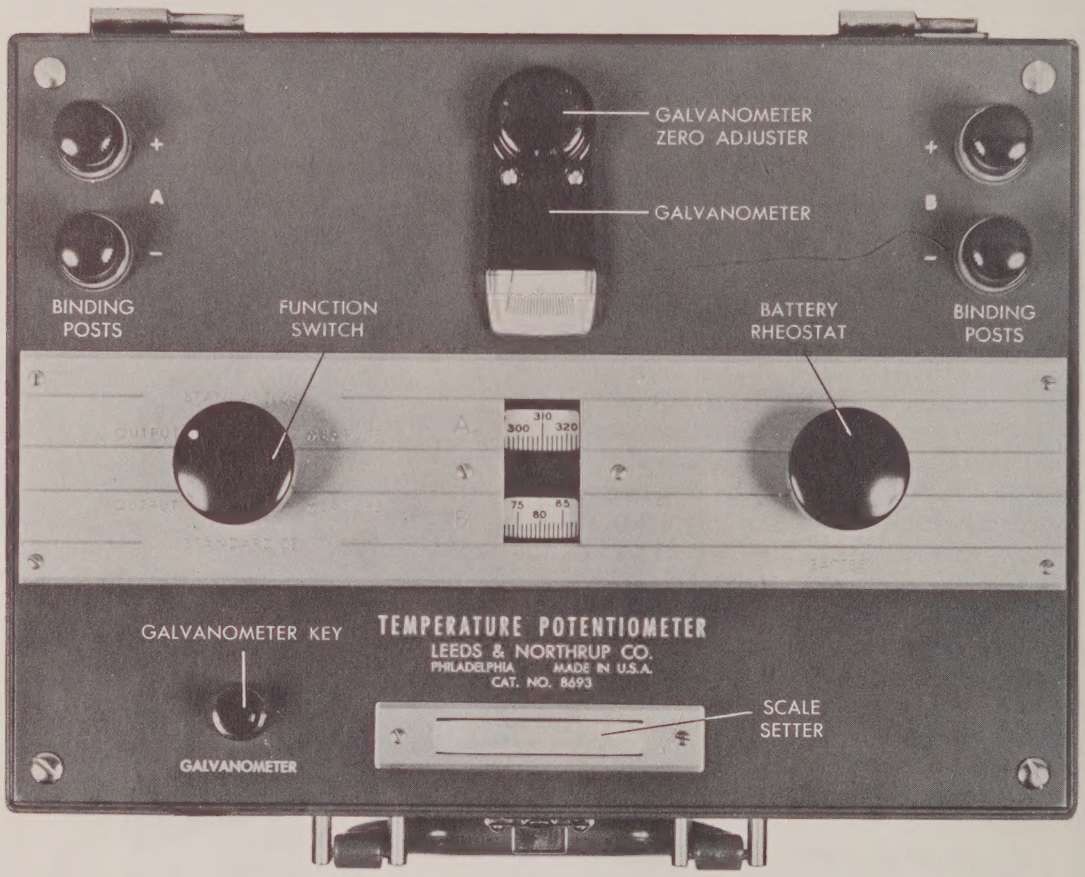

Fig. 2—Control panel of 8693 Portable Temperature Potentiometer.

3. CONTROL PANEL FEATURES

FUNCTION SWITCH

MEASURE A (or B) position - permits making temperature or millivolt measurements with scale setter on A (or B) range respectively

STANDARDIZE A (or B) position - permits adjustment of battery current by battery rheostat to standardize A (or B) potentiometer circuit respectively

OUTPUT A (or B) position - provides calibrated voltage at A (or B) binding posts respectively for checking potentiometer-type instruments

BATTERY RHEOSTAT

Adjusts battery current for standardizing potentiometer circuits

for both ranges

SCALE SETTER

Adjusts position of measuring slidewires and scales in relation to fixed positions of measuring slidewire contacts and scale indices

GALVANOMETER KEY

Up position - opens galvanometer circuit

Down position - closes galvanometer circuit - key can be locked in this position by turning it clockwise

BINDING POSTS

A (or B) - for attaching connections from thermocouples, other emf sources, or potentiometer-type instruments to be checked

GALVANOMETER

Indicates unbalance between potentiometer circuits and measured emf's

SCALES

Indicate values of temperature or emf being measured (or output on "Output" position)

4. EXPLANATION OF OPERATION

As shown schematically in Fig. 7, the 8693 Temperature Potentiometer fundamentally consists of two separate two-branch potentiometer circuits - one for the A range and the other for the B range. Both circuits are balanced manually by the rotation of the scale setter that extends through the control panel. This setter is coupled mechanically to the drum on which the slidewires and scales are mounted. Both circuits operate identically. The A range circuit operates as follows.

A. Standardization

The circuit is arranged with two branches of equal resistance to which current is supplied by battery BA. The magnitude of the current is controlled by battery rheostat S3 which is in series with the battery. The circuit is designed to provide a battery drain of 5 ma with the current dividing equally between the two branches. When the current in each branch is adjusted to 2.5 ma, the circuit is standardized.

Standardization is effected by placing the function switch in the standardize position and by depressing the galvanometer key. This connects galvanometer GA and shunt resistor R1 (which critically damps the

galvanometer) into a loop which includes resistor C and the standard cell. The standard cell emf is always equal to 1.0195 volts absolute (within 0.1%). Resistor C is chosen to be 407.8 ohms so that with 2.5 ma flowing, the drop across C is 0.0025 x 407.8 or 1.0195 volts.

If the current flowing through C is equal to 2.5 ma, the two opposing voltages of the loop balance each other and no current flows in the loop. If the current is not exactly 2.5 ma, the resultant voltage unbalance causes an error current to flow through the galvanometer, thereby causing it to deflect from its zero (null balance) position. This unbalance is corrected by adjusting the battery rheostat until the galvanometer balances. This indicates that 2.5 ma is flowing through C and that the two opposing voltages are balanced. Thus standardization is accomplished by the null-balance method.

Since the battery is connected in either the A or B range circuit at all times, there is a continuous current drain from it. Thus the battery emf will decrease gradually. This decrease is corrected by standardizing the curcuit before each series of measurements or checks and also at regular intervals depending upon the stability of the battery.

As the battery emf decreases, repeated standardizations cause more and more of the battery-rheostat resistance to be adjusted out of the circuit. When all the resistance has been adjusted out (that is, the battery rheostat is at the end of its travel), the currents in the circuit can no longer be standardized unless the battery is replaced with a fresh one.

B. Measurement

When measuring temperature or millivoltage, the function switch is placed in the measure position and the galvanometer key is depressed. This connects the thermocouple or emf source to the circuit through the galvanometer. The unknown temperature or millivoltage is then measured by rotating the scale setter in the proper direction until the galvanometer is balanced. Thus the emf from the thermocouple or other source is balanced by the potential difference existing between the measuring slidewire contact and the junction of resistors D and C. The temperature or millivoltage is then indicated under the scale index.

Measuring slidewire S, trimmer rheostat S2, and resistors G, K, and D have been selected to make the potential difference between the measuring slidewire contact and the junction of resistors D and C vary through the measuring range. Resistor B has been selected to make the total resistance of the upper branch equal to that of the lower branch.

(1) Temperature Ranges

Automatic reference-junction compensation is provided for temperature ranges. To provide this compensation, resistor D is temperature sensitive and the reference (cold) junction of the thermocouple is located inside resistor D which is mounted on the circuit panel. This is

accomplished by using a D resistor composed of copper and nickel, by connecting the thermocouple to the binding posts with extension wire*, by using binding post studs composed of material having thermo-electric characteristics similar to those of the extension wire, and by connecting the binding posts to the reference-junction compensating points with extension wire. The circuit is so designed that the reference-junction compensating points are located inside resistor D, thereby actually extending the thermocouple to the inside of resistor D.

This resistor, over a limited range, has a temperature characteristic that matches that of the thermocouple being used. That is, with constant 2.5 ma current flowing through D, any change in the temperature of D produces a corresponding change in the potential drop across D. The change in potential drop across D for a given temperature variation is equal to the change in the output of the thermocouple subjected to the same variation. It causes the potential difference between the measuring slidewire contact and the junction of resistors D and C to vary automatically. Since resistor D surrounds the reference-junction compensating points (reference junction of the thermocouple), the resistor is affected by the same temperature variations that affect the thermocouple's reference junction. Resistor D therefore compensates for any change in the thermocouple's reference-junction temperature.

The composition and resistance of resistor D depends upon the type of thermocouple and the average operating temperature at the reference-junction compensating points. Therefore, the proper value of D, as determined by the above conditions, was used to compute the total lower-branch resistance of the circuit. Since no compensation would be required if the reference junction were at the reference temperature** - that is, 32 F (0 C) - the resistance value of D at 32 F (0 C) must be balanced out of the circuit. This was done by including this value in resistor G.

(2) Millivolt Ranges

Automatic reference-junction compensation is not included in the millivolt range circuits. Therefore in such circuits, resistor D is not temperature sensitive, the binding posts have copper studs, and no reference-junction compensating points are provided. Such circuits measure directly the millivolt output of the thermocouple or emf source connected to them.

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* Wire having thermo-electric characteristics similar to those of the thermocouple.

** For a given type of thermocouple the millivolt outputs corresponding to various hot junction temperatures are given in a table listed in Directions 077989, "Conversion Tables for Thermocouples". These tabular values are based upon the use of a thermocouple whose reference (cold) junction is at the reference temperature specified in the table. This temperature is usually 32 F (0 C).

C. Checking

Checking of similar potentiometer-type instruments is accomplished by placing the function switch in the output position (thereby shorting out the galvanometer), by rotating the scale setter until the desired temperature or millivoltage is indicated under the scale index, and by depressing the galvanometer key. The reading on the instrument being checked should then be identical or equivalent to the potentiometer scale setting within the combined adjustment accuracy of both instruments.

5. OPERATING INSTRUCTIONS

The potentiometer is shipped from the factory completely prepared for immediate use. No loose parts are supplied, as all parts, including the battery, are contained in the case.

A. Precautions

To protect the galvanometer whenever the potentiometer is not being used, place the FUNCTION switch in either of the OUTPUT positions and unlock the GALVANOMETER key.

The potentiometer contains a standard cell. It is an unsaturated cell and should be used where the ambient temperature remains between 32 F (0 C) and 122 F (50 C).

B. Adjust Galvanometer Zero

To adjust the galvanometer zero, place the FUNCTION switch in one of the STANDARDIZE positions. Make certain that the GALVANOMETER key is in its UP position. Then turn the galvanometer zero adjuster until the galvanometer pointer is at zero.

C. Standardize Circuit

To standardize either circuit - that is, to adjust the current in the circuit - proceed as follows:

Place the FUNCTION switch in the pertinent STANDARDIZE position.

Check the galvanometer zero and, if necessary, adjust it.

Depress or lock down the GALVANOMETER key. If the galvanometer pointer deflects from its zero (null balance) position, adjust the BATTERY rheostat until the galvanometer pointer balances at its zero position.

Standardize the circuit in use before each initial measurement or check. Also standardize at regular intervals depending upon the stability of the battery.

TABLE I—EXTENSION WIRE

THERMOCOUPLE		EXTENSION WIRE	
+	−	+	−
Iron	Constantan	Iron	Constantan
Copper	Constantan	Copper	Constantan
Chromel	Alumel	Chromel Copper Iron	Alumel Constantan Cupronel
Plat. Rhodium	Platinum	Copper	#11 Alloy

D. Measure Temperature

To measure temperature with a scale calibrated in degrees, proceed as follows:

- Connect the thermocouple to the pertinent BINDING POSTS with the proper extension wire as determined from Table I. Make sure that the polarities of the connections are correct.

- Standardize the circuit

- Place the FUNCTION switch in the pertinent MEASURE position, depress or lock down the GALVANOMETER key, and then rotate the SCALE setter until the galvanometer is balanced. Now release or unlock the GALVANOMETER key and read the temperature under the pertinent scale index.

E. Measure Millivoltage

Millivolt range circuits can be used to measure the millivolt outputs of thermocouples or other emf sources.

(1) Output of Thermocouple

To measure the output of a thermocouple when using a millivolt scale, proceed as instructed in either of the following methods.

(a) Ice Bath Method

In this method the thermocouple is connected to the BINDING POSTS as shown in Fig. 3. The junctions formed at the connections of the copper and extension wires are held at 32 F (0 C). In effect the circuit constitutes a thermocouple with its reference (cold) junction at 32 F (0 C).

To make the measurement, proceed as follows:

- Connect the thermocouple to the pertinent BINDING POSTS

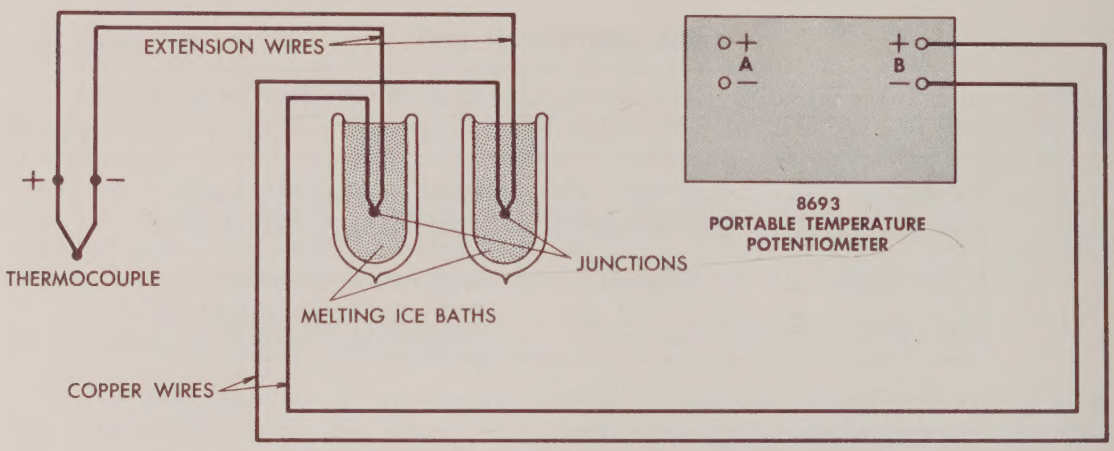

Fig. 3—Connections for measuring output of thermocouple using ice bath method.

as shown in Fig. 3. Use extension wire as determined from Table I. Make sure that the polarities of the connections are correct.

- Use well compacted melting ice baths to maintain the temperature of the copper-to-extension wire junctions. It is permissible to use a single ice bath, provided the junctions are electrically insulated. A coating of paraffin will provide the required insulation.

- Immerse the junctions at least four inches in the ice baths and allow time for them to reach ice bath temperature.

- Standardize the circuit in use.

- Place the FUNCTION switch in the pertinent MEASURE position, depress or lock down the GALVANOMETER key, and then rotate the SCALE setter until the galvanometer is balanced. Now release or unlock the GALVANOMETER key and read the millivolts under the pertinent scale index.

To convert the above millivolt reading into a temperature reading equivalent to the temperature at the thermocouple's measuring junction, determine the temperature corresponding to the above millivoltage from the proper conversion table in Directions 077989, "Conversion Tables For Thermocouples". This will be the temperature detected by the thermocouple.

(b) Thermometer Method

In this method the thermocouple is connected to the binding posts with either copper or extension wire. If copper wire is used, the reference junction is at the junction of the copper and thermocouple wires; if extension wire is used, the reference junction is at the binding posts.

To make the measurement, proceed as follows:

- Connect the thermocouple to the pertinent BINDING POSTS with either copper wire or extension wire as determined from Table I. Make sure that the polarities of the connections are correct.

- Standardize the circuit.

- Place the FUNCTION switch in the pertinent MEASURE position, depress or lock down the GALVANOMETER key, and then rotate the SCALE setter until the galvanometer is balanced. Now release or unlock the GALVANOMETER key and read the millivolts under the pertinent scale index.

To convert the above millivolt reading into a temperature reading equivalent to the temperature at the thermocouple's measuring junction, proceed as follows:

- Measure the temperature at the thermocouple's reference junction with a suitable thermometer*.

- Determine the millivoltage corresponding to the above temperature from the proper conversion table in Directions 077989.

- Add algebraically the millivoltage corresponding to the reference junction temperature to the millivolt reading of the potentiometer.

- Determine from the proper conversion table the temperature corresponding to the above resultant millivoltage. This will be the temperature detected by the thermocouple.

For example: Assume that the thermocouple is composed of Chromel and Alumel and that its output as measured by the potentiometer is 11.63 mv. Also assume that the temperature at the thermocouple's reference junction as measured by a thermometer is 86 F. Refer to the conversion table for Chromel vs. Alumel thermocouples, based on a reference-temperature of 32 F, for the millivoltage corresponding to 86 F. This is found to be 1.20 mv. Now add algebraically the 11.63 mv to the 1.20 mv. This equals 12.83 mv. Again refer to the conversion table for the temperature corresponding to 12.83 mv. This is found to be 599 F and is the temperature detected by the thermocouple.

(2) Output of Other Emf Source

To measure the millivolt output of an emf source when using a millivolt scale, proceed as follows:

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*The thermometer accuracy should be such that the accuracy of the measurement is not adversely affected by the use of this thermometer.

- Connect the source to the pertinent BINDING POSTS with copper wire. Make sure that the polarities of the connections are correct.

- Standardize the circuit.

- Place the FUNCTION switch in the pertinent MEASURE position, depress or lock down the GALVANOMETER key, and then rotate the SCALE setter until the galvanometer is balanced. Now release or unlock the GALVANOMETER key and read the millivolts under the pertinent scale index.

F. Check Similar Potentiometer-Type Instruments

The potentiometer can be used to check similar potentiometer-type instruments, such as recorders, controllers, and indicators. If the potentiometer has a temperature range, it can be used to check instruments having automatic reference-junction compensation and temperature ranges within the range of the potentiometer. If the potentiometer has a millivolt range, it can be used to check instruments having millivolt ranges or, when used with the proper conversion tables, it can be used to check instruments having automatic reference-junction compensation and temperature ranges within the equivalent millivolt range of the potentiometer.

(1) With Temperature Circuit

To check a recorder or controller having a temperature range with automatic reference-junction compensation, proceed as follows:

- Stop the recorder or controller and disconnect the thermocouple(s) from the thermocouple terminals or connectors. Make sure that the pen, temperature index, or print wheel are properly aligned as directed in the direction book of the recorder or controller.

- Connect the pertinent BINDING POSTS on the potentiometer to the proper thermocouple terminals or connectors on the recorder or controller with extension wire as determined from Table I. Be sure that the polarities of the connections are correct.

- Standardize the instrument being checked as directed in its direction book. Also standardize the potentiometer circuit.

- Place the FUNCTION switch in the pertinent OUTPUT position, rotate the SCALE setter until the desired check temperature is indicated under the pertinent scale index, and lock down the GALVANOMETER key.

- Start the recorder or controller and allow it to reach a balance. The pen, scale pointer, or print wheel should then register the same temperature as that set on the potentiometer within the combined adjustment accuracy of both instruments.

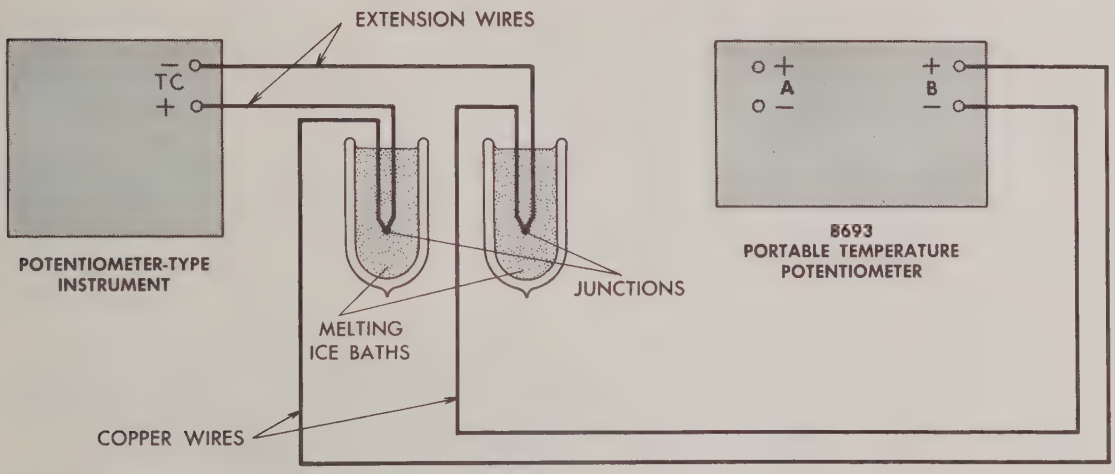

Fig. 4—Connections for checking potentiometer-type instrument using ice bath method.

To check manually-operated indicators, follow the same procedures described in the previous paragraphs. However the main dial of the indicator being checked must be turned until its galvanometer balances at zero (null balance). The reading on the main scale of the indicator then should check with the temperature setting of the potentiometer within the combined adjustment accuracy of both instruments.

NOTE: This is a check on the instrument only. If there is thermocouple trouble, replace the thermocouple or make further checks on it to determine its error.

(2) With Millivolt Range Circuit

To check potentiometer-type instruments having millivolt ranges without automatic reference-junction compensation, proceed as follows:

- As directed in the direction book of the instrument being checked, adjust the instrument's galvanometer to its mechanical zero position. Also standardize the instrument.

- Connect the potentiometer's pertinent BINDING POSTS to the proper binding posts or terminals of the instrument. Use copper wire to do this. Make sure that the polarities of the connections are correct.

- Standardize the potentiometer circuit.

- Place the FUNCTION switch in the pertinent OUTPUT position, rotate the SCALE setter until the desired millivoltage is indicated under the pertinent scale index, and lock down the GALVANOMETER key.

- Allow the instrument to operate to a galvanometer balance or,

if it is a manually operated instrument, turn its main dial until its galvanometer balances at zero (null balance). The reading on the main scale of the instrument should then check with the millivolt setting of the potentiometer within the combined adjustment accuracy of both instruments.

To check potentiometer-type instruments having temperature ranges with automatic reference-junction compensation, proceed as instructed in either of the following methods.

(a) Ice Bath Method

- As directed in the direction book of the instrument being checked, adjust the instrument's galvanometer or balancing system to its mechanical zero position. Also standardize the instrument.

- Connect the pertinent BINDING POSTS of the potentiometer to the proper thermocouple binding posts or terminals of the instrument as shown in Fig. 4. Use extension wire as determined from Table I. Make sure that the polarities of the connections are correct.

- Use well compacted melting ice baths for maintaining the temperature of the copper-to-extension wire junctions. It is permissible to use a single ice bath, provided the junctions are electrically insulated. A coating of paraffin will provide the required insulation.

- Immerse the junctions at least four inches in the ice baths and allow time for them to reach ice bath temperature.

- Standardize the potentiometer circuit and place the FUNCTION switch in the pertinent OUTPUT position.

- From the proper conversion table in Directions 077989, determine the millivolt equivalent of the temperature at which it is desired to check the instrument.

- Rotate the SCALE setter until the above millivolt value is indicated under the pertinent scale index. Then lock down the GALVANOMETER key.

- Allow the instrument to operate to a balance or, if it is a manually-operated instrument, turn its main dial until its galvanometer balances at zero (null balance).

The temperature reading on the main scale of the instrument being checked should then be correct within the combined adjustment accuracy of both instruments.

(b) Thermometer Method

- As directed in the direction book of the instrument being

checked, adjust the instrument's galvanometer or balancing system to its mechanical zero position. Also standardize the instrument.

- Connect the potentiometer's pertinent BINDING POSTS to the proper thermocouple binding posts or terminals of the instrument being checked. Use extension wire as determined from Table I. Make certain that the polarities of the connections are correct.

- Standardize the potentiometer circuit and place the FUNCTION switch in the pertinent OUTPUT position.

- From the proper conversion table in Directions 077989, determine the millivoltage corresponding to the temperature at which it is desired to check the instrument.

- Measure the temperature at the binding posts of the potentiometer with a suitable thermometer*.

- From the same conversion table determine the millivoltage corresponding to the temperature at the binding posts.

- Subtract algebraically the millivoltage corresponding to the temperature at the binding posts from the millivoltage corresponding to the temperature at which it is desired to check the instrument.

- Rotate the SCALE setter until the above resultant millivoltage is indicated under the pertinent scale index. Then lock down the GALVANOMETER key.

- Allow the instrument to operate to a balance or, if it is a manually-operated instrument, turn its main dial until its galvanometer balances at zero (null balance).

The temperature reading on the instrument being checked should then be correct within the combined adjustment accuracy of both instruments.

6. RANGE CHANGE INSTRUCTIONS

To change either of the present ranges of the potentiometer to a new range, proceed as follows:

- Carefully remove the control panel assembly from the case. Do this by loosening the four panel mounting screws sufficiently to disengage the fasteners. Rest the assembly face down on a suitable surface such as a work bench or table. Take care not to scratch or damage the

*The thermometer accuracy should be such that the accuracy of the measurement is not adversely affected by the use of this thermometer.

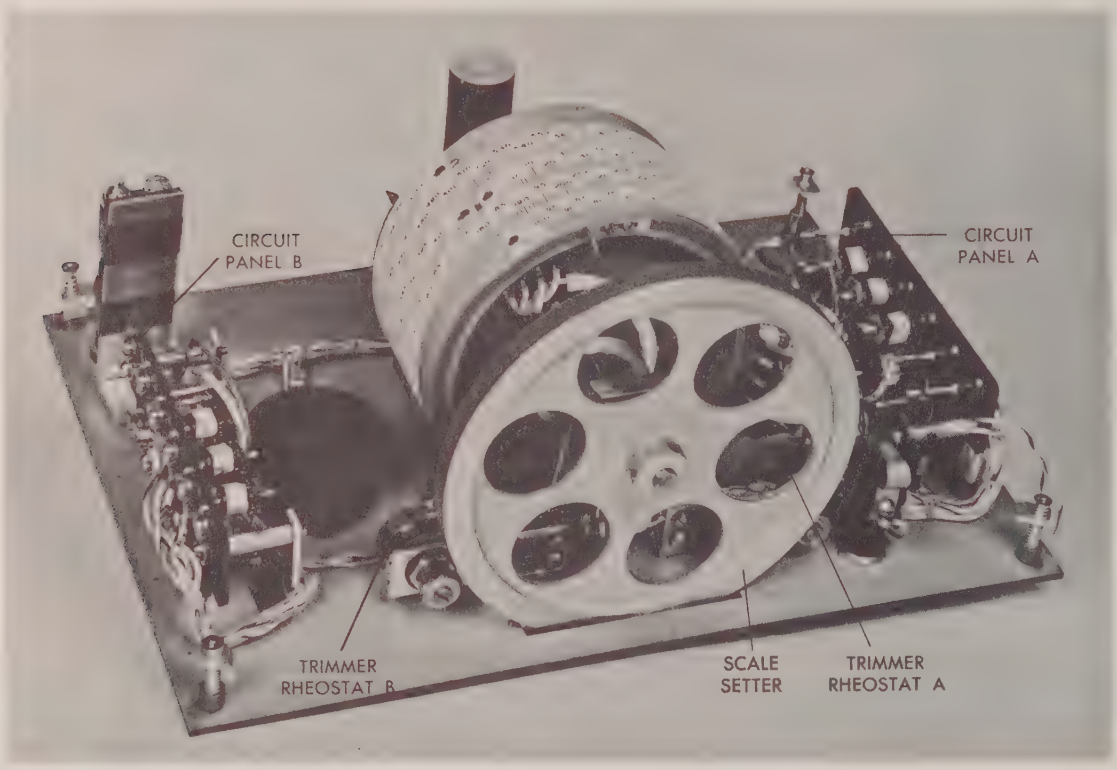

Fig. 5—Underside of control panel assembly (viewed from "knurled wheel" side of assembly).

surfaces of the knobs, binding posts, etc. Figs. 5 and 6 show the underside of the control panel assembly.

- Disconnect from the pertinent circuit panel the two leads that are attached to the binding post studs. Do this by loosening the bottom nut on each binding post.

- If a new stud(s) is supplied with the range change parts, replace the present stud(s) with the new one(s). To do this, first remove the two nuts from the binding post to free the stud. Then remove the cap from the stud.

CAUTION: WHEN REPLACING THE BINDING POST STUD ON WHICH THE STANDARD CELL ASSEMBLY IS MOUNTED, TAKE CARE NOT TO DAMAGE THE STANDARD CELL AS THE ASSEMBLY IS FREED FROM ITS MOUNTING IN THE PROCESS.

- Mount the new stud(s) in the binding post(s) by reversing the above procedure. Make certain that the standard cell assembly, if freed from its mounting, is remounted properly.

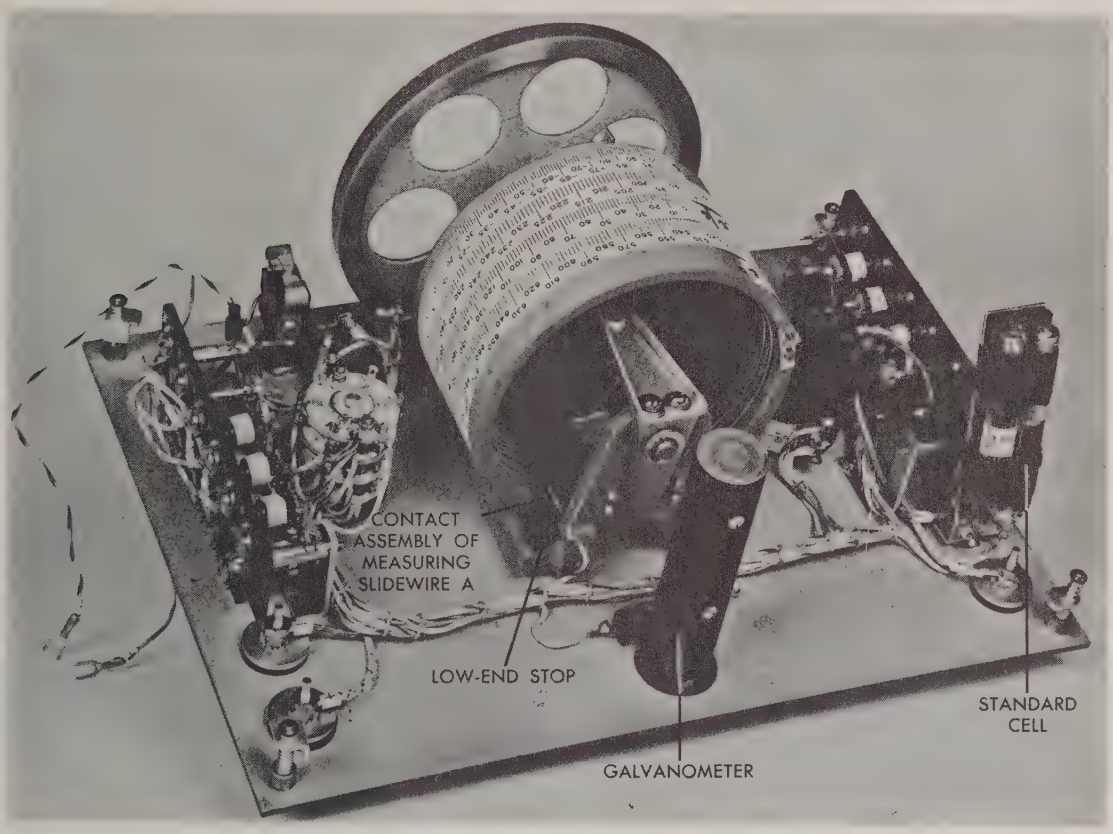

Fig. 6—Underside of control panel assembly (viewed from "galvanometer" side of assembly).

- Remove the disconnected circuit panel* and replace it with the new one*. To facilitate this, all terminal lugs on the wiring leads to and from the removed circuit panel are suitably marked to correspond to the markings of the terminals on the new circuit panel and to the markings of the binding posts.

- Remove the pertinent scale from the slidewire drum by removing the two screws that secure the scale to the drum.

CAUTION: WHEN REMOVING THE SCALE, TAKE CARE NOT TO DAMAGE THE HAIRLINE INDICES OF THE SCALES.

- Mount the new scale, making sure that its mounting conforms to the original mounting arrangement. This is facilitated by proceeding

* The resistor connected between terminals 5 and 6 of the circuit panels is not used in the potentiometer circuits associated with the panels. Therefore disregard its presence.

as follows:

- Rotate the slidewire drum to its low-end stop. (This stop is mounted on the galvanometer side of the drum.) Then reverse the rotation until the tapped holes for mounting the scales are accessible.

- Carefully slide the new scale (face down with its low end towards the function switch) under the slidewire drum.

CAUTION: DO NOT KINK OR DAMAGE THE SCALE AND DO NOT DAMAGE THE HAIRLINE INDICES OF THE SCALES.

- Attach the low end of the scale to the tapped hole that is in line with the low-end mounting screw of the other scale. Use one of the removed screws to do this. Now wrap the scale around the drum by rotating the drum towards its high-end stop. Make sure that the scale butts against itself and is tightly wrapped around the drum. Fasten the high (slotted) end of the scale to the drum with the remaining screw. If there is any slack in the scale, take it up.

7. CALIBRATION

This section outlines the proper procedures for checking the calibration of the potentiometer circuits. Such a check is necessary for the circuit whose range has been changed. It is necessary for both circuits when the measuring slidewire assembly has been disturbed or removed. It is also necessary for the circuit whose measuring slidewire contact assembly (or contact) has been disturbed or replaced. The user may also wish to check the calibration of the potentiometer circuits periodically.

To check and, if necessary, adjust the calibration of either circuit proceed as follows: Make all adjustments and settings and take all readings as accurately as possible.

A. Millivolt Range Circuit

(1) Standardize the circuit and then place the FUNCTION switch in the pertinent OUTPUT position.

(2) Carefully remove the control panel assembly from the case by loosening the four panel screws sufficiently to disengage the fasteners. Rest the assembly on a suitable surface so that it leans on the scale setter. Do not disconnect any wiring.

(3) Connect a source of calibrated voltage to the pertinent BINDING POSTS with copper wire.

(4) Rotate the SCALE setter until the low-end division of the pertinent scale is under its scale index.

(5) Apply a millivolt value equivalent to the low-end value of the scale.

(6) Now place the FUNCTION switch in the pertinent MEASURE position and lock down the GALVANOMETER key.

(7) Adjust the position of the pertinent slidewire contact on its slidewire until the galvanometer balances. To do this loosen the screws that secure the contact assembly to the slidewire casting, adjust the contact position as required, and then tighten the screws to secure the contact assembly in place. Make sure that the contact bears against the slidewire with a force of 2 to 3 ounces. (Refer to Section 8 for instructions for measuring and adjusting the contact force.)

(8) Rotate the SCALE setter until the high-end division of the scale in under the scale index.

(9) Now apply a millivolt value equivalent to the high-end value of the scale.

(10) Loosen the locknut on the pertinent trimmer rheostat (S2 or S4) and adjust the rheostat until the galvanometer balances.

(11) Repeat Steps 4 to 10 inclusive. Then tighten the locknut on the trimmer rheostat to secure its adjustment.

(12) Other points on the scale may now be checked by proceeding in a manner similar to that described above. Do not disturb the position of the slidewire contact or the adjustment of the trimmer rheostat when making these checks. The limit of error of these checks should not exceed ±0.2% of the circuit's range span.

(13) Finally place the FUNCTION switch in the OUTPUT position, unlock the GALVANOMETER key, remove the connections from the BINDING POSTS, and remount the control panel assembly in the case. Tighten the four panel mounting screws to engage the fasteners.

B. Temperature Range Circuit

Temperature range circuits may be checked by either of the following methods.

(1) Thermometer Method

Proceed as directed in the calibration instructions for the millivolt

range circuit except determine the millivolt values required for Steps 5, 9, and 12 by proceeding as follows:

Measure the temperature at the potentiometer binding posts with a suitable thermometer*.

From the proper conversion table in Directions 077989 (32 F or 0 C), determine the millivoltage corresponding to the temperature at the binding posts.

From the same table, determine the millivoltage corresponding to the low-end temperature value of the scale.

Subtract algebraically the millivoltage corresponding to the temperature at the binding posts from the millivoltage corresponding to the low-end temperature value of the scale. The resultant millivoltage is the millivolt value required for Step 5.

To determine the millivolt values for Steps 9 and 12, proceed in a manner similar to that described above.

(2) Ice Bath Method

Proceed as directed in the calibration instructions for the millivolt range circuit except make the connections required for Step 3 and determine the millivolt values required for Steps 5, 9, and 12 by proceeding as follows:

Connect the source of calibrated voltage to the pertinent BINDING POSTS in a manner similar to that indicated in Fig. 4. Use extension wire as determined from Table I. Make sure that the polarities of the connections are correct.

Use well compacted melting ice baths for maintaining the temperature of the copper-to-extension wire junctions. It is permissible to use a single ice bath, provided the junctions are electrically insulated. A coating of paraffin will provide the required insulation.

Immerse the junctions at least four inches in the ice baths and allow time for them to reach ice bath temperature.

Determine the millivoltage corresponding to the low-end temperature value of the scale by referring to the proper conversion table in Directions 077989 (32 F or 0 C). This is the millivolt value required for Step 5.

Determine the millivoltage corresponding to the high-end

*The thermometer accuracy should be such that the accuracy of the measurement is not adversely affected by the use of this thermometer.

temperature value of the scale by referring to the same table. This is the millivolt value required for Step 9.

To determine the millivolt values required for Step 12, proceed in a manner similar to that described in the preceding two paragraphs.

8. MEASURING SLIDEWIRE CONTACT FORCE ADJUSTMENTS

CAUTION: IN MAKING THE FOLLOWING CHECKS AND ADJUSTMENTS, TAKE CARE NOT TO ALLOW THE CONTACTS TO SNAP DOWN ON THE SLIDEWIRES, AS THIS MAY NICK THE SLIDEWIRES AND ADVERSELY AFFECT CALIBRATION.

The contacts should bear against their respective slidewires with a force of 2 to 3 ounces. If the contact force is too low, unreliable electrical connection may result. Excessive force will cause rapid wear of the contacts.

When a contact is disturbed or a new contact assembly installed, the contact force should be measured. To do this first rotate the slidewire drum to its high-end stop. Then use a spring scale with an L-shaped hook on its end to make the measurement. If the force (applied as radially as possible) required to just lift the contact off the slidewire is not within 2 to 3 ounces (56 to 84 grams), readjust the contact force. Excessive contact force can be relieved by bending the contact outward without removing the contact assembly from its mounting on the slidewire assembly. To increase the force remove the contact assembly from the slidewire, bend the contact as required, remount the contact assembly, and recalibrate the circuit as instructed in Section 7.

9. MAINTENANCE

The 8693 Temperature Potentiometer is designed for reliable trouble-free operation. With reasonable care in handling and use, no normal maintenance is required other than periodic replacement of the battery. Instructions for battery replacement and other less frequent maintenance procedures are given below.

A. Battery

A 1.5 volt battery is mounted in the potentiometer. When it is no longer possible to standardize the potentiometer circuits, replace the battery with a new one. The battery may easily be replaced after removing the cover plate secured to the bottom of the case by a thumb screw.

B. Cleaning the Measuring Slidewires

The slidewires may require occasional cleaning over extended periods of time, depending upon the conditions under which the potentiometer

is used.

Carefully remove the control panel assembly from the case by loosening the four panel mounting screws sufficiently to disengage the fasteners. Rest the assembly on a suitable surface so that it leans on the scale setter.

Rub a clean cloth, moistened with Cramolin (L&N Part No. 090019, 2 oz. bottle of the solution), over the contact surface of the slidewire. Allow the Cramolin to remain for at least 30 seconds and then remove any excess with a clean section of cloth. Do not apply any lubricant to the slidewire and never use an abrasive material on it as this would destroy the uniformity of the slidewire.

C. Standard Cell

The standard cell may be expected to maintain correct emf for several years unless it is accidently short-circuited. If trouble encountered in calibrating the potentiometer circuits cannot be located by other tests, measure the open-circuit voltage of the cell with a precision potentiometer, such as the 7553 Type K-3 Universal Potentiometer or equivalent. Make sure that the cell is disconnected and is in its normal operating condition when making this measurement. If the open-circuit voltage is less than 1.0175 volts, the cell is unserviceable and must be replaced.

To remove the standard cell for test or replacement, proceed as follows:

Carefully remove the control panel assembly from the case. Rest it on a suitable surface so that it leans on the scale setter.

Unsolder the standard cell's red and blue leads from the bracket on which the cell is mounted.

Now remove the cell from the bracket by unwinding the tape (#33 Scotch Electrical Tape) that secures the cell to the bracket.

To replace the cell or mount a new one, reverse the procedure outlined above. Make sure that the mounting of the cell conforms to the original mounting arrangement.

D. Galvanometer

To replace the galvanometer, simply remove its two mounting screws and then withdraw it from the panel. Unsoldering of the galvanometer leads is not required, as the potentiometer is so designed that the galvanometer is disconnected from the potentiometer circuits when it is removed from the panel.

To remount the galvanometer or to mount a new one, reverse the above procedure.

Static charges on the galvanometer window may cause sporadic needle deflections. Hence it is suggested that an anti-static coating on the outside of the galvanometer window be prepared as follows:

- Dilute a small amount of "Joy" liquid soap approximately 50% by volume with tap water.

- Pour the solution over the window and allow it to drip dry.

- Lightly polish the window to remove any haze after the soap solution has dried.

E. Measuring Slidewire Contact Assemblies

At yearly intervals, or more frequently if the instrument is subjected to continuous use, inspect the measuring slidewire contact(s) for wear. The contact(s) should be replaced before the soft metal of the contact(s) is worn through. When the contact assembly is replaced (by unsoldering the lead and removing two screws), the contact pressure and instrument calibration should be adjusted as directed in Section 7.

F. Scale Window

If it ever becomes necessary to replace the scale window, first remove the knobs from the FUNCTION switch and BATTERY rheostat. Then remove the metal plate to which the window is attached. Replace the window with a new one. Then remount the metal plate and the knobs.

TABLE II—REPLACEMENT PARTS

DESCRIPTION	PART NO.
Galvanometer	062111
Binding Post, Head	002199
Binding Post, Stud (Iron)	061469
Binding Post, Stud (Constantan)	061468
Binding Post, Stud (Copper)	061467
Function Switch	032229
Scale Window	066125
Battery Rheostat	013204
Galvanometer Key	PI-123-L
Standard Cell	130007
Slidewire Contact Assembly (Range A)	029611
Slidewire Contact Assembly (Range B)	029610
Trimmer Rheostat (S2 or S4)	013203
1-1/2 Volt Battery (Burgess 4FH or equivalent)	Std. 2233-1
Panel Mounting Screw Assembly	
Screw	4-4-1-24
Bushing	6-2-1-2
Spring, Upper	28-1-3-10
Spring, Lower	28-1-3-9
Clamp	72-4-1-1
Retaining Ring	27-3-3-12

10. REPLACEMENT PARTS AND AUXILIARY EQUIPMENT

A. Replacement Parts

The replacement parts for the 8693 Temperature Potentiometer are listed in Table II.

B. Auxiliary Equipment

Description	Part No.
Thermocouple Assemblies, Parts, and Accessories	See Catalog EN-S2

APPENDIX

INSTRUCTIONS FOR ORDERING

RANGE CHANGE PARTS FOR STANDARD RANGES

TABLE A1—STANDARD RANGES

TYPE OF THERMOCOUPLE	RANGE	SUFFIX NUMBER
Iron-Constantan	0 to 300 F	048
	-100 to +500 F	009
	0 to 1000 F	003
	400 to 1200 F	172
	0 to 1600 F	142
	0 to 2000 F	049
	900 to 2000 F	164
	0 to 200 C	007
	-100 to +400 C	166
	0 to 500 C	022
	0 to 800 C	057
	0 to 1100 C	165
Chromel-Alumel	0 to 700 F	200
	0 to 1200 F	024
	0 to 2000 F	001
	0 to 2500 F	143
	1000 to 2500 F	046
	0 to 600 C	062
	0 to 1200 C	047
	500 to 1200 C	167
Plat.-Plat. 10% Rhodium	0 to 2500 F	033
	0 to 3200 F	144
	2000 to 3200 F	052
	0 to 1600 C	067
Plat.-Plat. 13% Rhodium	0 to 3200 F	145
Copper-Constantan	-340 to +230 F	168
	-100 to +400 F	032
	0 to 650 F	201
	-200 to +150 C	170
	-100 to +300 C	146
	0 to 400 C	169
Millivolts	5 to 0 to 5	084
	0 to 10	044
	0 to 25	127
	0 to 50	045

Select the appropriate suffix number of the new range from the list of standard ranges in Table A1. Add this number to the base numbers of the resistor panel and scale. Check the material of the present binding post studs by referring to Table A2; if incorrect for the new range specify the proper stud(s).

For example: Assume that the present range of the potentiometer is 0-2500 F for Plat.-Plat. 10% Rhodium thermocouples and the desired new range is 0-1000 F for Iron-Constantan thermocouples. The suffix number of the new range as determined from Table A1 is 003. The material of both present binding post studs as determined from Table A2 is copper. This material is incorrect for the new range. As determined from Table A2, the proper binding post studs for the new range are 061469 Positive (+) Stud (Iron) and 061468 Negative (-) Stud (Constantan). The order for the range change parts should therefore read as follows:

QUANTITY	PART NO.	DESCRIPTION
1	605 [0][0][3]	Resistor Panel
1	189 [0][0][3]	Scale
1	061469	Positive (+) Binding Post Stud (Iron)
1	061468	Negative (-) Binding Post Stud (Constantan)

If both ranges of the 8693 Portable Temperature Potentiometer are to be changed, two resistor panels, two scales, and required binding post studs must be specified.

TABLE A2—BINDING POST STUDS

TYPE OF THERMOCOUPLE	BINDING POST STUDS			
	Positive (+)		Negative (-)	
	Material	Part No.	Material	Part No.
Iron-Constantan	Iron	061469	Constantan	061468
Chromel-Alumel	Copper	061467	Constantan	061468
Plat.-Plat. 10% Rhodium	Copper	061467	Copper	061467
Plat.-Plat. 13% Rhodium	Copper	061467	Copper	061467
Copper-Constantan	Copper	061467	Constantan	061468
Millivolts	Copper	061467	Copper	061467

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RECTIONS

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VIKING LABORATORIES INC.

8694-2-□ AND 8695-2-□-□

TEMPERATURE POTENTIOMETERS

LEEDS & NORTHRUP

VIKING LABORATORIES INC.

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SPECIFICATIONS

RANGES

Any one of the temperature ranges listed in Table I.
Other ranges (with a minimum span of 5 mV) are available on special order.

LIMIT OF ERROR

±0.3% of range.

REFERENCE JUNCTION COMPENSATION

Automatic.

DETECTOR

Sensitivity: 50 microvolts per meter division.
Input Resistance: 10,000 ohms.
Noise: Less than 10 microvolts peak-to-peak.
Response Time: 1.5 seconds.

BATTERIES

Potentiometer Circuit: 1.5 volts (two "D" cells connected in parallel). Battery life is approximately 8 to 10 months.

Detector Circuit: 4.05 volts (two Hg. batteries). Battery life is approximately 1000 operating hours.

APPROXIMATE DIMENSIONS

8" high X 6-1/4" wide X 6" deep
(203 x 159 x 152 mm).

WEIGHT

Approximately 4.5 pounds (2 kg).

8694-2-□ AND 8695-2-□-□

TEMPERATURE POTENTIOMETERS

1. GENERAL INFORMATION

The 8694-2-□ and 8695-2-□-□ Temperature Potentiometers are small, light weight, portable instruments for measuring temperature by means of thermocouples.

The 8694-2-□ is a single range instrument with one pair of binding posts for connections to a thermocouple. The 8695-2-□-□ is a double range instrument with two pairs of binding posts. Table I lists the standard ranges available and the appropriate suffix for each.

Both instruments can also be used as sources of calibrated voltages in terms of their individual temperature ranges. Each instrument includes a built in solid-state null detector, standard cell, and potentiometer and detector batteries.

E6880

Fig. 1–8694-2 Potentiometer, general view.

TABLE I–STANDARD RANGES

TYPE OF THERMOCOUPLE	RANGE (IPTS-68)	SMALLEST SCALE DIVISION	SUFFIX NUMBER		
			FOR 8694-2		
			FOR 8694-2	INSIDE SCALE "A"	OUTSIDE SCALE "B"
Type J	-100 to +400F	2F	952	752	952
	0 to 1200F	5F	953	753	953
	0 to 2000F	10F	954	NA	954
	300 to 1200F	5F	955	NA	955
	-100 to +300C	2C	951	751	951
	0 to 600C	2C	957	757	957
Type K	0 to 1200F	5F	961	761	961
	0 to 2500F	10F	962	762	962
	1100 to 2500F	5F up to 2000F 10F above	963	NA	963
	0 to 600C	2C	964	NA	964
	0 to 1200C	5C	965	765	965
Type S	0 to 3200F	20F up to 1200F 10F above	971	NA	971
	1500 to 3200F	10F	972	NA	972
	800 to 1600C	5C	973	773	973
Type R	0 to 3200F	20F up to 1200F 10F above	976	NA	976
	0 to 1700C	10C	978	778	978
Type T	0 to 750F	5F	983	783	983
	-100 to +400F	2F	984	784	984
	-50 to +200C	2C	985	785	985
	-100 to +300C	2C	986	NA	986

2. DESCRIPTION OF MAJOR COMPONENTS

2A. Function Switch

(1) 8694-2-□

The function switch (see Fig. 1) has three positions and selects the operation for which the instrument is to be used. Table II lists these switch positions and the corresponding functions.

TABLE II–FUNCTION SWITCH POSITIONS

SWITCH POSITION	FUNCTION
OUTPUT	Provides calibrated voltages in terms of potentiometer range. (Null detector is turned off and its input is shorted.)
STD	Standardize potentiometer current.
MEAS	Measure thermocouple voltages.

(2) 8695-2-□-□

The function switch (see Fig. 2) has six positions, three for each of two ranges A and B. The function of each position is as shown in Table II.

E6881

Fig. 2–8695-2 Potentiometer, general view.

2B. Battery Rheostat

The battery rheostat provides the necessary adjustment to standardize the current in the potentiometer circuit. It consists of two rheostats operated by a single shaft and provides both coarse and fine adjustment. The rheostat knob is turned in one direction to make the coarse adjustment and in the reverse direction, through a 45° angle, to make the fine adjustment.

The internal connections of the 8694-2 and 8695-2 are such that the rheostat knob should be turned in a clockwise direction for the coarse adjustment to move the detector pointer to the right, and in a counterclockwise direction for the fine adjustment to move the detector pointer to the left.

2C. Detector Key

The DET (detector) key serves to connect the null detector to the potentiometer circuit. The key should be left in the up position when not making measurements. This disconnects the detector from the circuit, protecting it from large signals which are possible while making connections to the potentiometer or while making connections to the potentiometer or while making preliminary adjustments.

The DET key must be closed (depressed) to determine circuit balance. It will lock closed if it is turned in a clockwise direction as it is depressed.

2D. Measuring Slidewire

This slidewire, operated by the knob directly above the window, is used to obtain a circuit balance when measuring the voltage (temperature) of a thermocouple or to set the value of the calibrated voltage when using the instrument as a voltage source.

The setting of the slidewire is read at the index of the window. In the case of the 8695-2, read the scale which corresponds to the range being used (A or B areas of the function switch).

2E. Null Detector

The null detector is a solid-state device with characteristics as indicated in the SPECIFICATIONS. It consists of the printed circuit board, zero adjuster, meter and batteries shown in Figs. 1, 2, 3 and 4.

2F. Standard Cell

The standard cell is mounted on a bracket on the underside of the top plate as shown in Figs. 3 and 4. It is an unsaturated cell and should be used where the ambient temperature remains between 0°C and 50°C (32°F and 122°F).

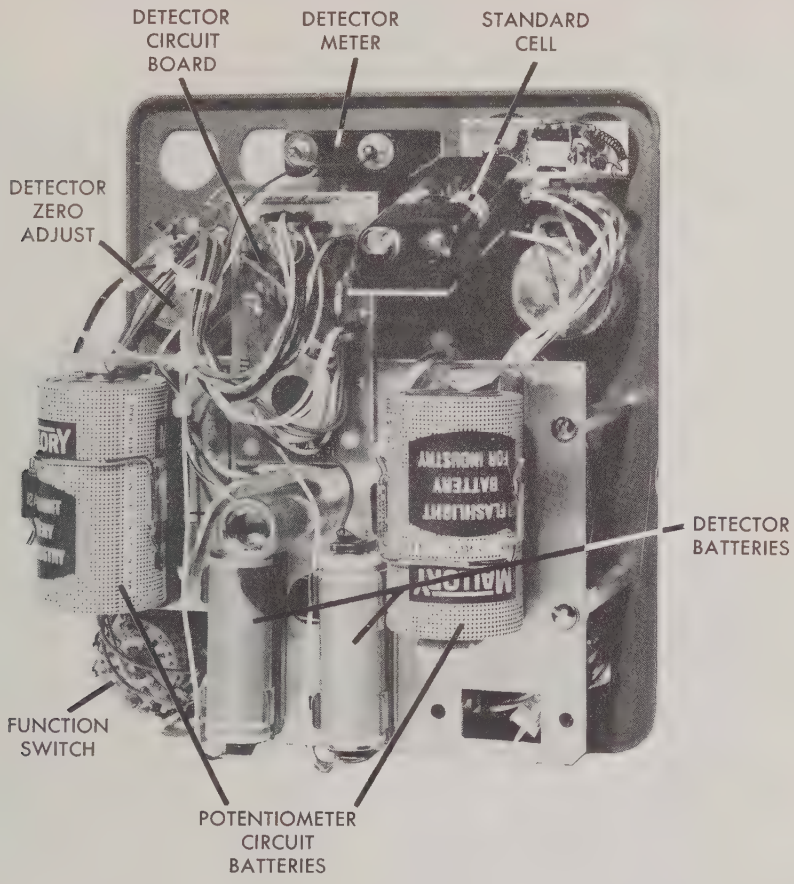


Fig. 3–8694-2 Potentiometer, underside of top plate.

2G. Potentiometer Batteries

Two size D flashlight batteries (connected in parallel) are used to supply current to the potentiometer circuit. These are mounted in spring clips as shown in Figs. 3 and 4.

3. PRINCIPLE OF OPERATION

3A. General Description

The basic measuring circuits of these instruments consist of dual branch configurations.

Fig. 5 shows the single range Cat. 8694-2 Potentiometer. The upper branch consists of end resistors G and B, plus the measuring slidewire S. The lower branch consists of the automatic reference-junction compensating resistor D, plus the standardizing resistor C.

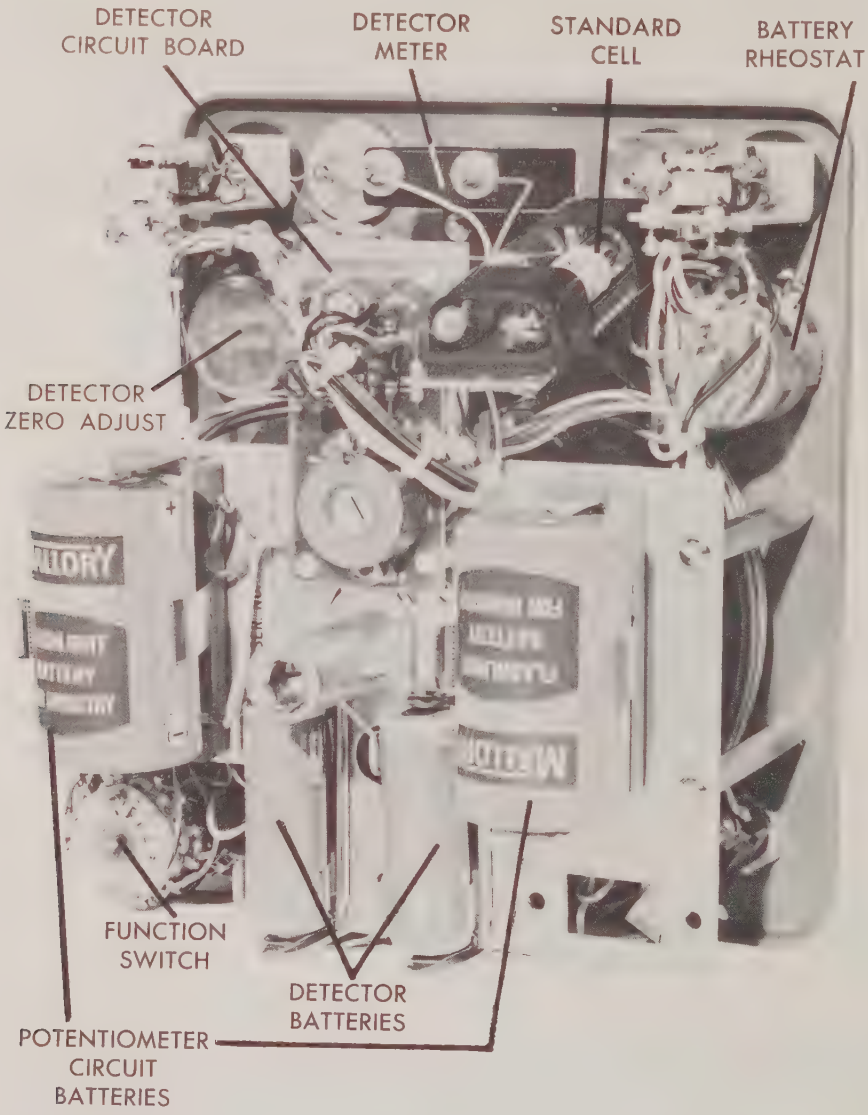


Fig. 4–8695-2 Potentiometer, underside of top plate.

In the case of the double range Cat. 8695-2 (Fig. 6) there are two separate dual branch potentiometer circuits, one for each range, each with its own circuit resistors. Either range is selected by means of the function switch. Range "A" consists of the measuring slidewire Sa and end resistors Ga and Ba plus the reference-junction resistor Da and the standardizing resistor Ca. Similarly, range "B" consists of Sb, Gb, Bb, Db, and Cb.

The branches are arranged so that they are of equal resistance. With the nominal 0.75 mA flowing in each branch, the total battery drain is 1.5 mA.

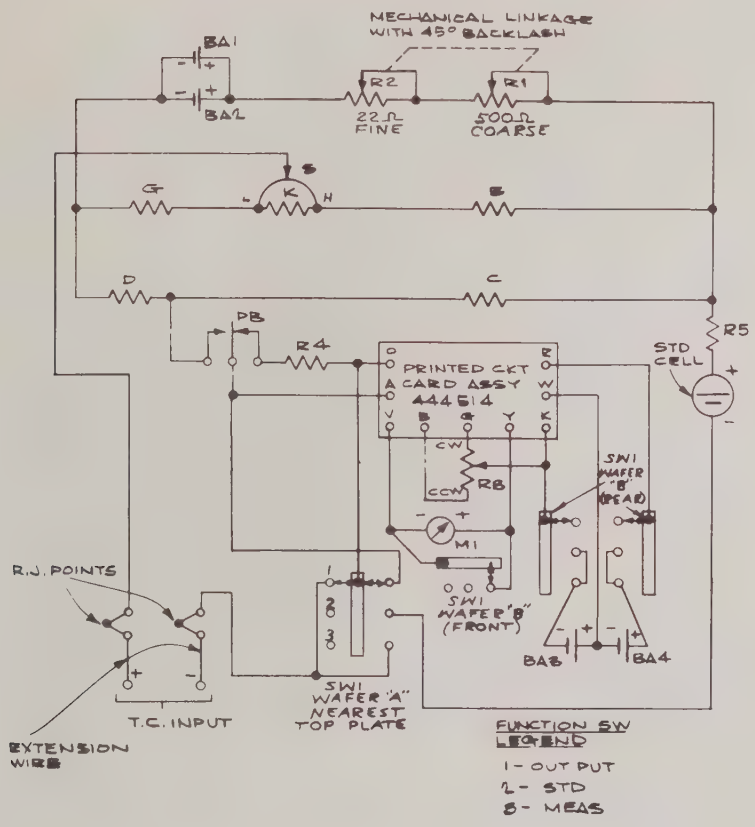


Fig. 5–8694-2 Potentiometer, schematic wiring diagram.

The reference junction resistor is connected in the circuit so that, in effect, it moves the fixed end of the thermocouple circuit to a point corresponding to the reference junction temperature. These resistors (D, Da, or Db in Figs. 5 and 6) are temperature sensitive and vary their resistance with changes in reference junction temperature corresponding to the slope of the temperature-emf curve for a specific thermocouple.

3B. Detailed Description

While the following descriptions refer basically to the single range 8694-2 per Fig. 5, they are also applicable to the double range 8695-2 per Fig. 6.

(1) Standardization

Standardization is accomplished by placing the function switch in the STD position and then depressing the DET key. This connects the detector into a loop which includes resistor C and the standard cell. The standard cell emf is equal to 1.0193 volts absolute (within 0.05%).

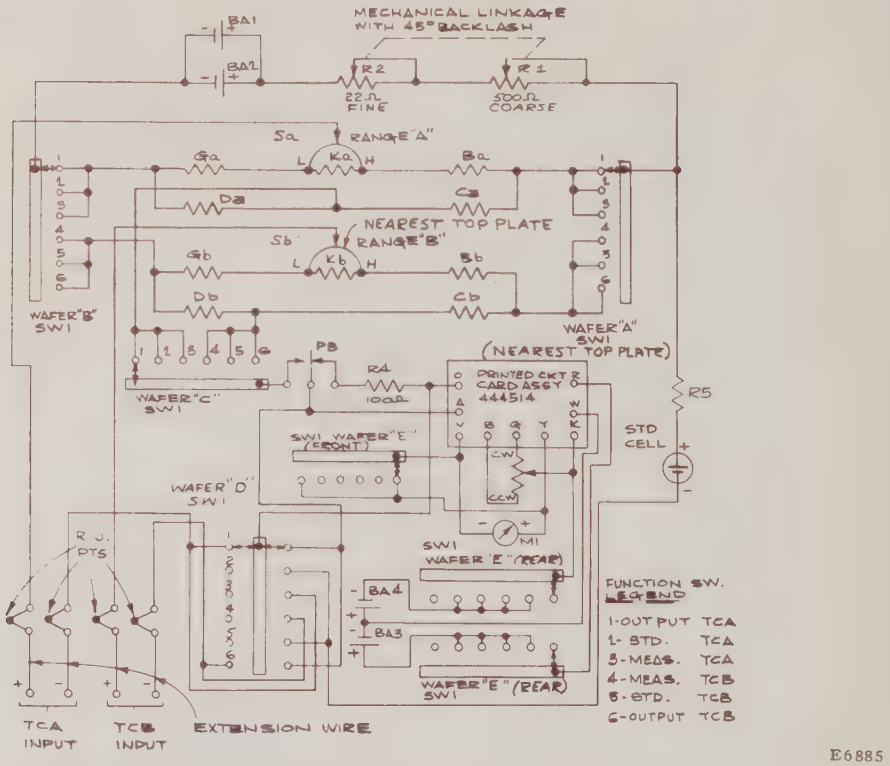


Fig. 6–8695-2 Potentiometer, schematic wiring diagram.

Resistor C has a value of 1359.07 ohms, so that with 0.75 mA flowing, the IR drop across C is equal to 1.0193 volts (within the required limits of accuracy).

If the current flowing through C is equal to 0.75 mA, the two opposing voltages of the loop balance each other and no current flows in the loop. If the current is not exactly 0.75 mA, the resultant voltage unbalance causes an error voltage to appear at the detector, thereby causing it to deflect from its zero (null balance) position. This unbalance is corrected by adjusting the BATTERY rheostat.

The measuring slidewire and resistors G and B have been selected to make the potential difference between the measuring slidewire contact and the junction of resistors C and D correspond to the temperature range.

Automatic reference junction compensation is achieved by (1) physically locating the reference (cold) junction of the thermocouple inside the temperature sensitive resistor D, (2) connecting the thermocouple to the binding posts with extension leadwire having thermoelectric characteristics similar to those of the thermocouple, (3) using binding

post studs composed of material having thermoelectric characteristics similar to those of the extension leadwire, and (4) by connecting the binding posts to the reference junction points with extension leadwire. Thus the circuit is designed so that the reference junctions are located inside resistor D, thereby actually extending the cold junction of the thermocouple to the inside of resistor D and therefore both at the same temperature.

Resistor D, over a specified range, has a temperature characteristic that matches that of the thermocouple being used. That is, with a constant 0.75 mA current flowing through D, any change in the temperature of D produces a corresponding change in the potential drop across D. The change in potential drop across D for a given temperature variation is equal to the change in the output of the thermocouple subjected to the same temperature variation, and causes the potential difference between the measuring slidewire contact and the junction of resistors C and D to vary automatically.

4. OPERATION

4A. Precautions

To prolong the life of the detector batteries, turn the function switch to an OUTPUT position and release the DET key to the up (open) position whenever the potentiometer is not being used.

To protect the standard cell, the instrument should be used or stored only where the temperature is within the limits indicated in Section 2F.

When the instrument will be stored or inoperative for months, remove all batteries to avoid possible damage from leakage.

Do not leave the function switch in a STD position for an extended period with the DET key locked down as this may damage the standard cell.

4B. Adjust Zero of Detector

Release the DET key to the open (up) position.

Turn the function switch to either STD or MEAS position and note the balance indication on the detector meter. If it does not balance at zero, turn the ZERO control until this balance is obtained.

Periodically, check the detector current-offset adjustment. To do this, proceed as follows:

Open circuit the + and – binding posts.

Turn the function switch to a MEAS position.

With the DET key up, zero the detector using the ZERO control.

Depress the DET key. The detector meter should not deflect more than 2 divisions. If it does, remove the instrument from its case and adjust the trimming potentiometer on the detector printed circuit board until this condition is met.

4C. Standardize Current in Potentiometer Circuit

Turn the function switch to the STD position (the one associated with the range being used in the case of the 8695-2).

Depress the DET key and note the detector for any deflection. If the pointer does not balance at zero, adjust the BATTERY rheostat until the detector pointer returns to zero.

4D. Measure Temperature

(1) 8694-2 Potentiometer

Connect the proper type thermocouple (refer to data on the scale) to the binding posts (with the proper extension leadwire, if necessary, as indicated in Table III) being sure to follow the polarity marks at the binding posts and in Table III.

Standardize the current in the potentiometer circuit as indicated in Section 4C.

Turn the function switch to the MEAS position, depress (and lock down if desired) the DET key, and then rotate the slidewire knob, Fig. 1, until the detector balances at zero. Release (or unlock) the DET key and read the temperature under the scale index at the window.

TABLE III – EXTENSION LEADWIRE

THERMOCOUPLE TYPE	DUPLEX EXTENSION LEADWIRE		
	Cover	+	–
J68	Black	Iron (white)	Constantan (red)
T68	Blue	Copper (blue)	Constantan (red)
	Yellow	Ni-Chr (yellow)	Ni-Al (red)
K68	Red	Copper (brown)	Constantan (red)
	White	Iron (green)	Cupronel (red)
R68 & S68	Green	Copper (black)	No. 11 Alloy (red)

(2) 8695-2 Potentiometer

Connect the proper type thermocouple (refer to data on the scale) to either binding posts A or binding posts B (with the proper extension leadwire, if necessary, as indicated in Table III) being sure to follow the polarity marks at the binding posts and in Table III.

Standardize the current in the potentiometer circuit as indicated in Section 4C.

To measure the temperature of the thermocouple connected to binding posts A, turn the function switch to the MEAS position for scale A, depress (and lock down if desired) the DET key, and then rotate the slidewire knob, Fig. 2, until the detector balances at zero. Release (or unlock) the DET key and read the temperature on scale A under the scale index at the window.

To measure the temperature of the thermocouple connected to binding posts B, turn the function switch to the MEAS position for scale B, depress (and lock down if desired) the DET key, and then rotate the slidewire knob, Fig. 2, until the detector balances at zero. Release (or unlock) the DET key and read the temperature on scale B under the scale index at the window.

4E. Supply Calibrated Voltages

CAUTION: This instrument can be used as a voltage source but it is not designed to supply current. Accuracy of the output voltage is decreased if current is drawn from the potentiometer. Therefore, it should be used only in null circuits where the voltage of the external circuit can be made equal and opposite to the voltage provided by the instrument.

Be sure all preliminary adjustments and checks have been made.

Close the DET key and lock it in this position to complete the circuit.

On the 8694-2, turn the function switch to the OUTPUT position while on the 8695-2, turn the function switch to either OUTPUT position, depending upon the range desired.

The calibrations of both the 8694-2 and 8695-2 are based on the IPTS-68 Temperature vs. Millivolt tables. These tables are referenced at 32°F or 0°C.

If the instrument ambient is 32°F or 0°C, its millivolt output is directly related to the scale setting and is converted to millivolts by referring to the appropriate IPTS-68 conversion table; e.g. 500°F scale setting and Type J (iron-constantan) thermocouple will produce an output of 14.108 millivolts.

Generally, however, the instrument would be used at some ambient other than 32°F or 0°C --- and the output voltage would be affected by the "D" reference-junction-compensation resistor. For example, an instrument with a 0 to 1200°F range, for use with a Type J thermocouple, is operating in an ambient of +77°F. The output voltage at a scale setting of 1000°F is determined as follows:

(1) Millivolts at 1000°F = 29.515 mV (from IPTS-68 Table)

(2) Millivolts at 77°F = 1.277 mV (from IPTS-68 Table)

(3) Subtracting (2) from (1), the millivolt output of the instrument will be 29.515-1.277 or 28.238 millivolts.

4F. Check Other Temperature-Range Null-Type Instruments

The 8694-2 and 8695-2 Potentiometers can be used to check temperature-range null-type instruments (with automatic reference-junction compensation and temperature ranges within the range of the checking instrument) where the output impedance of the 8694-2 or 8695-2 does not appreciably affect the sensitivity of the instrument being checked.

To check an automatic-balancing null-type system, such as an electronic recorder or controller, proceed as follows:

Stop the recorder or controller and disconnect the thermocouple(s) from it. Make sure that the scale, indicating pointer, and pen (or print wheel) are properly aligned as indicated in the direction book for the instrument.

Use extension leadwire, as determined from Table III, and connect the binding posts of the 8694-2 or 8695-2 to the proper thermocouple terminals or connectors of the recorder or controller. Be sure the polarities of the connections are correct.

Standardize the instrument being checked, as indicated in its direction book and also standardize the 8694-2 or 8695-2.

Turn the function switch to the proper OUTPUT position, rotate the main slidewire knob until the desired temperature value is under the index of the window, and lock down the DET key.

Start the recorder or controller and allow it to reach a balance. This point should be at the same temperature point as set on the 8694-2 or 8695-2, within the combined adjustment accuracy of both instruments.

To check a manually-balanced null-type indicator, follow the procedure outlined above except the indicator being checked must be balanced manually.

NOTE: This is a check on the instrument only. Other checks must be used to detect trouble external to the instrument.

5. MAINTENANCE

5A. Remove Top Plate From Case

A quick-connect fastener, on the bottom of the case, holds the top plate (cover) and case together. All internal components are mounted on the underside of the top place as shown in Figs. 3 and 4.

To remove the top plate, rotate the fastener in a counterclockwise direction approximately 90 degrees (a quarter turn). The fastener will spring out (but remain attached to the case) to release the top plate. Then carefully lift the top plate up out of the case.

5B. Replace Top Plate in Case

The quick-connect fastener is placed just off-center. Thus, in fitting the top plate into the case, the detector meter end of the top plate must be at the end of the case to which the handle is attached. Carefully fit the top plate into the case. Turn the fastener (counterclockwise) if necessary, to permit the top plate to fit down over the edges of the case. Then push in on the fastener and turn it clockwise to lock the top plate in place.

5C. Replace Batteries

When the BATTERY rheostat reaches its limit (while standardizing) because of depleted batteries, the two size D batteries, Figs. 3 and 4 should be replaced.

To replace these batteries, remove the top plate from the case, as indicated in Section 5A. Then remove the batteries from the clips and insert fresh batteries. The batteries should be placed in the clips as in Figs. 3 and 4 with the positive (center) terminal against the longer spring contact.

When it is no longer possible to zero the null detector or adjust the detector current offset, replace the two 4.05 volt batteries, Figs. 3 and 4.

To replace these batteries, remove the top plate from the case as indicated in Section 5A. Then pry the batteries from their holders and insert fresh batteries. Observe the polarity indicated on the battery holders.

Replace the top plate in the case as indicated in Section 5B.

CAUTION: Batteries should be replaced at least once every 8 to 10 months, regardless of use, to minimize the possibility of leakage and resulting damage to the instrument.

5D. Replace Detector Circuit Board

To replace the detector circuit board, proceed as follows:

(1) Place the function switch in an OUTPUT position.

(2) Remove the top plate from the case as indicated in Section 5A.

(3) Disconnect all leads attached to the circuit board.

(4) Carefully pry the present board from its mounting insulators and then press the new board in place. Reconnect all previously disconnected leads. The marking at each terminal on the board should agree with the color of the wire going to that terminal.

5E. Replace Standard Cell

Remove the top plate from the case as indicated in Section 5A. Carefully unsolder the connections to the standard cell (see Figs. 3 and 4). Note the position of the standard cell on its mounting plate as the new one must be placed in this same position. Remove the tape holding the cell in place on the mounting plate and remove the cell.

Place the new cell in position, on the mounting plate, in the same position as the one just removed. Wind tape around the cell and mounting plate to hold the cell in place. Then carefully solder the cell connections. Be sure these connections are made the same as the old cell.

5F. Cleaning

(1) General

The vinyl finish on the instrument case has considerable resistance to chipping and scratching. If necessary, the case may be cleaned with a soft cloth dampened with water containing a small amount of mild detergent.

(2) Binding Posts and Insulators

If the binding posts and/or insulators become dirty or contaminated, clean them with a clean solution of 5% detergent and water.

Since the insulation of the binding posts is a plastic, chemical solutions or solvents should not be used for cleaning.

(3) Slidewire

The slidewire may require occasional cleaning, over extended periods of time, depending upon the conditions under which the instrument is used. Remove the top plate from its case as indicated in Section 5A. Clean and lubricate the slidewire winding only with the approved cleaner-lubricant, Leeds & Northrup Part No. 124179. Do not clean the slidewire with any other lubricant or with an abrasive material.

TABLE IV–BINDING POST STUDS

TYPE OF THERMOCOUPLE	BINDING POST STUDS			
	POSITIVE (+)		NEGATIVE (–)	
	MATERIAL	PART NO.	MATERIAL	PART NO.
Type J68	Iron	061469	Constantan	061468
Type K68	Copper	061467	Constantan	061468
Type S68	Copper	061467	Copper	061467
Type R68	Copper	061467	Copper	061467
Type T68	Copper	061467	Constantan	061468

6. REPLACEMENT PARTS

DESCRIPTION	L&N PART NO.
Battery (Size D, flashlight)	056012
Battery (4.05 V, Hg.)	056056
Standard Cell	130007
Detector Meter	021185
Detector Circuit Board	444514
Binding Posts	
Head	002199
Stud	See Table IV
Window (lucite strip)	066029
DET key	031014
BATTERY Rheostat	013032
ZERO Control Rheostat	013496
Main Slidewire Knob	002204
BATTERY Rheostat Knob	002215
ZERO Control Knob	002200
Function Switch Knob	002203
Decal	052704

7. AUXILIARY EQUIPMENT

7A. Leather Protecting Case

A leather protecting case can be ordered as a separate item. The potentiometer can be operated while in the case or it can be easily removed from the case by simply pulling up on the instrument.

To obtain the leather case, order L&N Part No. 039733.

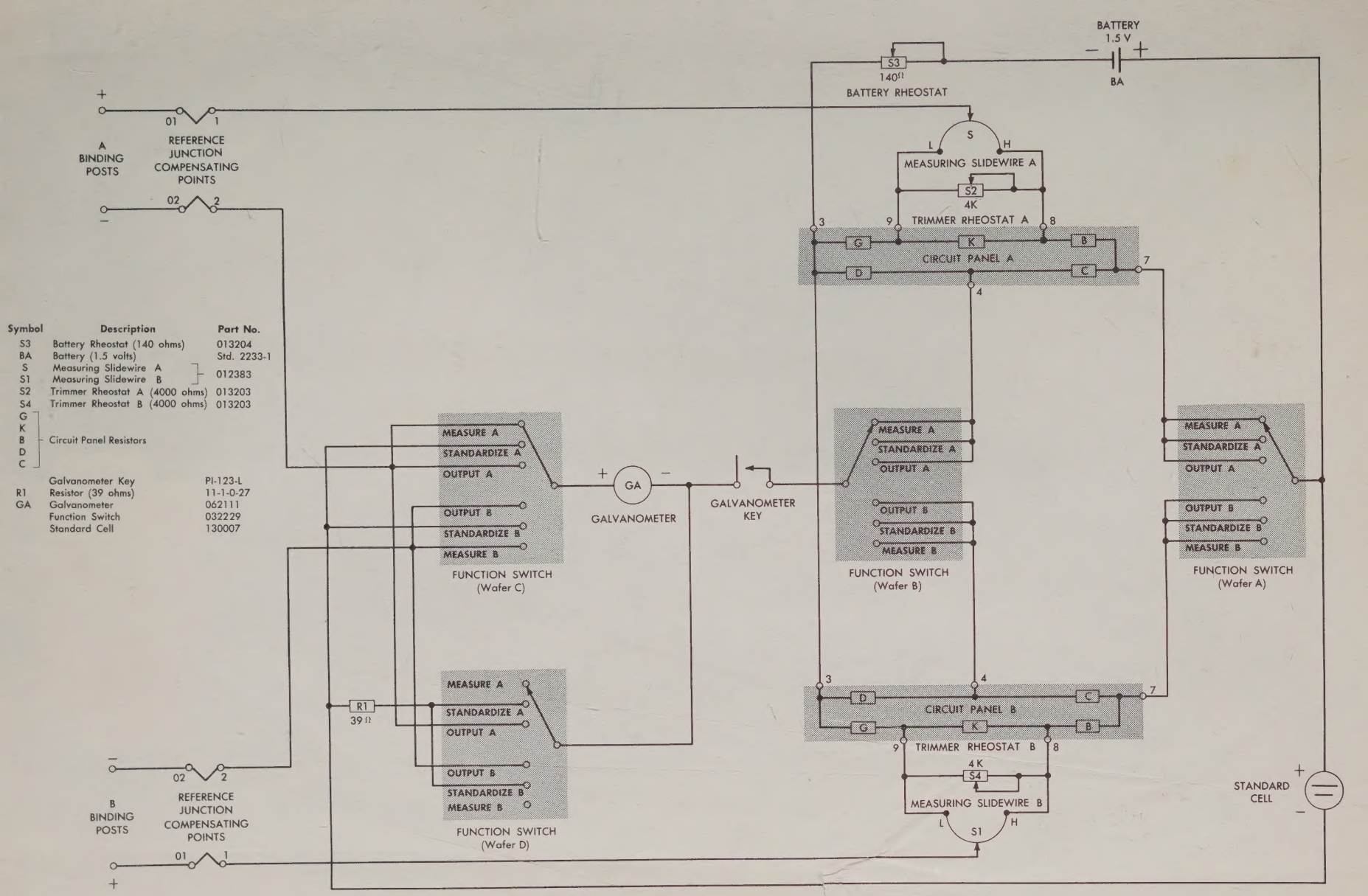
7B. Decal

One decal is supplied as a convenient method for indicating general information pertaining to a specific instrument. This decal may be marked with pencil or ink and attached to any clean surface on the instrument or on the leather case. The markings on the decal may be erased and changed at any time.

Directions for applying the decal are given on the back of each decal.

8. RANGE CHANGE

A separate direction book, sent with range change kits, gives the details for changing ranges in the field.



Symbol	Description	Part No.
S3	Battery Rheostat (140 ohms)	013204
BA	Battery (1.5 volts)	Std. 2233-1
S	Measuring Slidewire A	012383
S1	Measuring Slidewire B	
S2	Trimmer Rheostat A (4000 ohms)	013203
S4	Trimmer Rheostat B (4000 ohms)	013203
G, K, B, D, C	Circuit Panel Resistors	
	Galvanometer Key	PI-123-L
R1	Resistor (39 ohms)	11-1-0-27
GA	Galvanometer	062111
	Function Switch	032229
	Standard Cell	130007

Fig. 7—Schematic diagram of 8693 Portable Temperature Potentiometer.

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